Bendix® Advanced Driver Assistance Systems (ADAS) Challenging Scenarios and System Limitations Overview

***Important:* Because each truck manufacturer may implement differing feature sets of the Bendix® Fusion™ system, check with the OEM or dealer to confirm available features and vehicle capabilities. Some of the scenarios within this document may or may not apply to your vehicle.**

OVERVIEW

Bendix® Advanced Driver Assistance Systems (ADAS) are intended to continuously monitor what is happening on and around the vehicle. However, all ADAS systems have limitations and may misinterpret a scenario, thereby potentially leading to system reactions that may differ from expectations (e.g. a false-positive response, where the system generates a response when it is not expected to or when a risk may not exist; or a false-negative response, where the system does not generate a response when it is expected to or when a risk may exist).

⚠WARNING

All ADAS systems are sensitive to conditions such as those described within this document, and all ADAS systems have limitations. It is unlikely that full elimination of unwanted false-positive or false-negative responses will be possible with this generation of technology. There is no substitute for a skilled, alert driver exercising safe driving techniques and proactive, comprehensive driver training. Responsibility for the safe operation of the vehicle remains with the driver at all times.

⚠WARNING

Bendix technologies complement safe driving practices. No commercial vehicle technology replaces a skilled, alert driver exercising safe driving techniques and proactive, comprehensive driver training. Never wait for the system to intervene. Responsibility for the safe operation of the vehicle remains with the driver at all times.

TECHNICAL ASSISTANCE

The Bendix Tech Team is available by phone at 1-800-AIR-BRAKE (1-800-247-2725), option 2, or by email at techteam@bendix.com. Representatives are available Monday through Thursday, 8:00 a.m. – 6:00 p.m., and Friday, 8:00 a.m. – 5:00 p.m. ET.

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DRIVER OVERRIDE

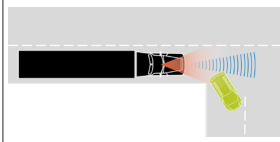
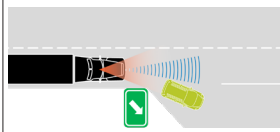
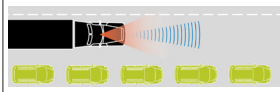
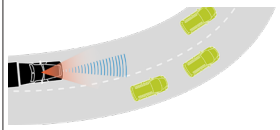
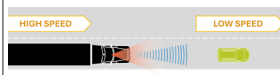
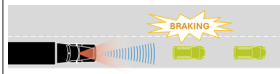
Drivers are capable of overriding system interventions.

- **Active Cruise with Braking (ACB):** You, the driver, can override an ACB system intervention by applying the accelerator pedal. ACB will be overridden until the accelerator is released; then, ACB will resume the original set speed and distance control automatically.
- **Autonomous Emergency Braking (AEB):** Once any type of an AEB event has started, you, the driver, can override its activation by applying a significant change in accelerator or steering position during the initial stage of braking or by making a full throttle application. The system may still respond to the situation with a warning and some braking before AEB is suppressed.
- **Lane Departure Warning (LDW), Highway Departure Warning (HDW), and Highway Departure Braking (HDB):** You, the driver, can activate the 15-minute LDW, HDW, and HDB disable switch when driving on roads with inconsistent lane markings that may cause excessive false warnings. Examples would include construction zones, poorly marked lanes, or lanes with missing markings. The system alerts will automatically become available again after 15 minutes or if the disable switch is pressed a second time.
- **High Beam Assist (HBA):** You, the driver, must always monitor the situation and intervene by switching the high beam headlights manually, if necessary. HBA is not a substitute for the driver's judgement of when to activate or deactivate the high beam headlights.

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CHALLENGING SCENARIOS

The following table describes some – not all – scenarios that may be challenging for any ADAS system, including the Bendix® Fusion™ System, Bendix® Wingman® Active Cruise with Braking System, Bendix™ BlindSpotter® Radar System, and Bendix™ VORAD® Radar System. Most scenarios assume one or multiple ADAS features are on and set.

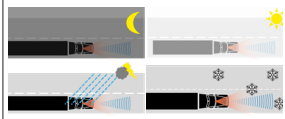
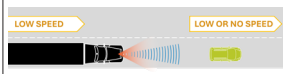
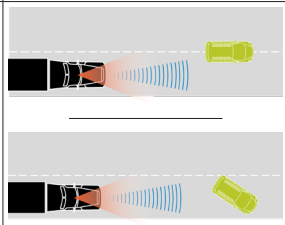
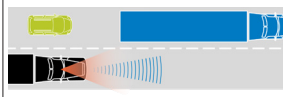
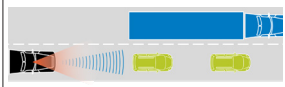
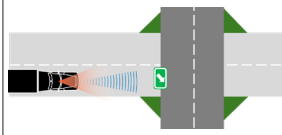
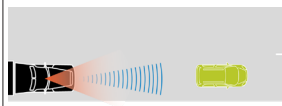
Challenging Scenario	Description	Illustration
The detected forward vehicle slows to make a turn or the host vehicle changes lanes behind a detected forward vehicle.	The system may intervene with an alert and/or vehicle braking as long as the system perceives the detected forward vehicle to be in the lane of travel. The system may not anticipate that the detected forward vehicle will depart the lane of travel.	
The detected forward vehicle slows and exits the highway, or the lane merges into additional lanes or an exit ramp.	Vehicles exiting a lane and/or lane line discontinuity may lead to the system tracking the detected forward vehicle for an extended period, which may result in a system alert and/or vehicle braking.	
The host vehicle is traveling in an environment where there are parked vehicles nearby and no lane lines.	The system may identify one of these vehicles as a detected forward vehicle, which may result in a system alert and/or vehicle braking.	
The host vehicle is traveling in a curve where there are other forward vehicles in the same or adjacent lanes.	The system may identify one of these vehicles as a detected forward vehicle, which may result in a system alert and/or vehicle braking. When traveling in a curve, the system may stop tracking the forward vehicle, which may delay or prevent a system alert and/or vehicle braking. Also, the system may not recognize detected forward vehicles as in-lane and/or may react late depending on road curvature.	
The host vehicle approaches slow or stopped forward vehicles at a high difference in speed.	The system may not have enough time to properly detect (alert) and react (apply vehicle braking) to a slow or stopped forward vehicle.	
The host vehicle approaches a forward vehicle that stops aggressively.	The system may not have enough time to properly detect (alert) and react (apply vehicle braking) to a forward vehicle that stops aggressively.	

IMPORTANT **Illustrations are representative only and not to scale.**

WARNING **You, the driver, are responsible for the control and safe operation of the vehicle. Never wait for an ADAS system to intervene.**

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CHALLENGING SCENARIOS (*continued*)

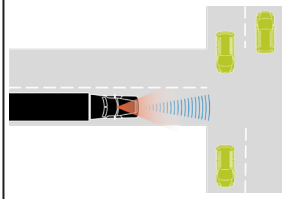
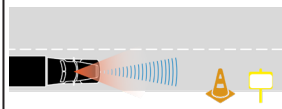
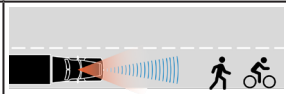
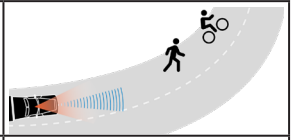
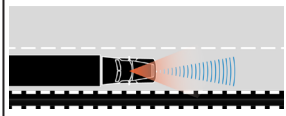
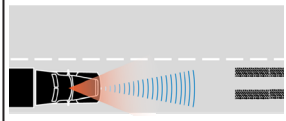
Challenging Scenario	Description	Illustration
The host vehicle is traveling in environmental conditions that may lead to limited visibility, including – but not limited to – low light, glare, heavy precipitation, etc.	Environmental conditions may impact the system's ability to detect forward vehicles or track lane markings, which may result in little to no system alert and/or vehicle braking.	
The host vehicle is traveling at a low speed and approaches a detected forward vehicle also traveling at a low speed.	The ADAS system has a minimum activation speed. Traveling below the minimum activation speed may result in little to no system alert and/or vehicle braking.	
The host vehicle approaches a forward vehicle that is laterally offset or rotated in the lane.	A vehicle that is offset or rotated in the host vehicle's lane of travel may not be detected by the system as a forward vehicle and may result in little to no system alert and/or vehicle braking.	
The host vehicle passes vehicles in an adjacent lane.	The system may interpret a vehicle in an adjacent lane as a detected forward vehicle and may result in a system alert and/or vehicle braking.	
The host vehicle approaches stationary vehicles in close proximity to each other.	Stationary vehicles in close proximity to each other may not be detected by the system and may or may not result in a system alert and/or vehicle braking.	
The host vehicle is traveling through an underpass or under an overhead sign.	Overhead signs, bridges, or other sizeable, stationary, metallic objects may be falsely detected, which may result in a system alert and/or vehicle braking.	
The host vehicle is approaching a forward vehicle on a road with missing, inconsistent, low-quality, or confusing lane lines.	Missing, inconsistent, low-quality, or confusing lane lines may impact the system's ability to detect a forward vehicle, which may result in little to no system alert and/or vehicle braking.	

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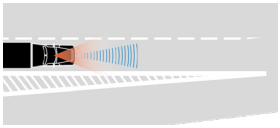
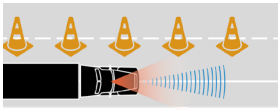
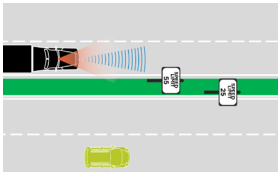
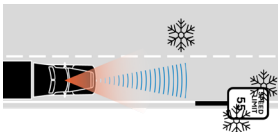
Challenging Scenario	Description	Illustration
The host vehicle approaches cross-traffic, such as an intersection or a round-about.	ADAS systems may react ONLY to vehicles or objects that the system determines are stationary or moving in the same direction as the host vehicle. The system DOES NOT respond to side-to-side moving vehicles or oncoming vehicles. The system will not provide an alert or vehicle braking as the host vehicle approaches vehicles or objects in these circumstances.	
The host vehicle encounters construction barrels, road signage, or other infrastructure near the driving lane.	Nearby roadside objects may be detected as pedestrians, which may result in a system alert and/or vehicle braking.	
The host vehicle encounters a pedestrian or cyclist in the lane of travel.	The system may not recognize a pedestrian or cyclist, which may result in little to no system alert and/or vehicle braking.	
The host vehicle is traveling in a curve and encounters a pedestrian or cyclist in the lane of travel.	The system may not recognize a pedestrian or cyclist as in-lane, which may result in little to no system alert and/or vehicle braking due to road curvature.	
The host vehicle is traveling on a straight road and encounters a pedestrian near the front of the vehicle.	The system may not recognize a pedestrian standing close to the front of the vehicle. The vehicle hood creates a front blind spot (red area) where the camera cannot detect pedestrians. As hood length increases, the size of this blind spot also may increase (purple area).	
The host vehicle is traveling on a road with a high-contrast environment (e.g., the edge of the road, a guardrail, or snow).	Road edges, guardrails, or other scenarios where there is a transition between dark and light may be misinterpreted as lane lines, which may result in a false system alert and/or vehicle braking.	
The host vehicle is traveling on a road with markings other than lane markings (e.g., tar lines, skid marks, cracks on the roadway, or severe high-contrast shadows).	Tar lines, skid marks, cracks, or severe or high-contrast shadows may be misinterpreted as lane lines, which may result in a false system alert and/or vehicle braking.	

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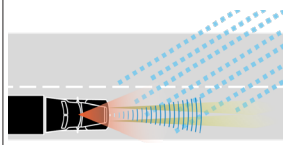
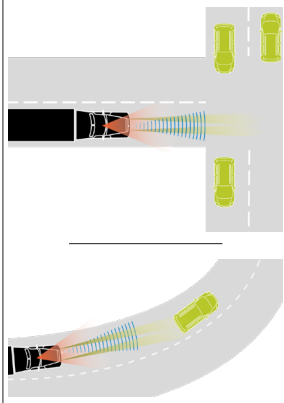
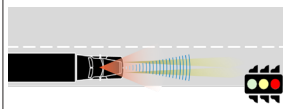
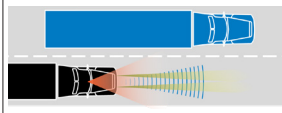
Challenging Scenario	Description	Illustration
The host vehicle is traveling on a road where the lane markings begin to converge, diverge, or narrow (e.g. temporary lines in construction areas, off-ramps, or merge zones).	If lane markings do not follow a consistent pattern or lane width, the system may trigger a false system alert and/or vehicle braking, or may result in little to no system alert and/or vehicle braking.	
The host vehicle is traveling where a shift in traffic patterns (e.g. construction zones) forces the host vehicle to utilize the shoulder.	The system may interpret this situation as a roadway departure, which may result in a false system alert and/or vehicle braking.	
The host vehicle is traveling near a parallel or frontage road.	The system may detect speed limit signs from a nearby road, which may result in a false system alert and/or vehicle dethrottle.	
The host vehicle is traveling on a road with multiple speed signs shown together or digital speed signs.	The system may misinterpret multiple speed limit sign values, advisory speed limit signs, or digital speed signs, which may result in a false system alert and/or vehicle dethrottle.	
The host vehicle is traveling on a road with other signs that include numbers.	The system may misinterpret signs with numbers as speed limit signs, which may result in a false system alert and/or vehicle dethrottle.	
The host vehicle is traveling on a road with tilted, rotated, or partially blocked speed signs.	The system may not detect speed signs in these conditions, which may result in a false system alert and/or vehicle braking, or little to no system alert and/or vehicle dethrottle.	

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CHALLENGING SCENARIOS (*continued*)

Challenging Scenario	Description	Illustration
The host vehicle is traveling in unusual lighting conditions or adverse weather conditions like dense fog or heavy precipitation.	Areas with insufficient or unusual lighting may result in an incorrect high beam recommendation. Conditions like dense fog or heavy precipitation may interfere with the proper high beam recommendation, which may result in an incorrect high beam recommendation.	
The host vehicle is traveling around tight curves, hilltops, depressions, or intersections.	The system may only detect a portion of the detected forward vehicle's taillights or headlights, which may result in an incorrect high beam recommendation.	
The host vehicle is traveling toward a solid or flashing red or yellow traffic light.	The system may misinterpret a red or yellow traffic light for the taillights of a preceding vehicle, which may result in an incorrect high beam recommendation.	
The host vehicle is passing or being passed by a long vehicle such as a tractor/ trailer.	If the host vehicle is being passed or being slowly overtaken by a long vehicle, the system may not recommend low beams until the taillights of the overtaking vehicle are in sight. Similarly, while passing or slowly overtaking a long vehicle, the system may recommend a high beam after the taillights of the overtaken vehicle are no longer in sight.	

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Systems Covered in this Overview

This document covers some – but not all – aspects of Bendix ADAS systems with an emphasis on conditions that may limit their performance. If after becoming familiar with the contents of this document you, the driver, still believe the ADAS system is not performing properly, Bendix recommends the following:

- Fully understand when the braking event occurred. Driver training may be required to fully understand how the system operates.
- Run the most current version of Bendix® ACom® Diagnostic Software to determine if an active fault exists with the system. Correct the fault(s) prior to placing the vehicle back in service.
- Verify the radar is operating the latest software version. The software version can be determined by using ACom Diagnostic Software or by contacting your Bendix account manager. The proper radar software version is intended to reduce sensitivity to road conditions that may cause a radar blind condition.

Refer to B2Bendix.com for related product documentation.

Document Number	Document Title
BW2489	Bendix® Antilock Braking System (ABS) Operator's Manual
BW2860	Bendix™ BlindSpotter® Collision Warning System Operator's Manual
SD-61-4933	Bendix™ BlindSpotter® Side Object Detection System Service Data Sheet
SD-61-5010	Bendix™ BlindSpotter® Side Object Detection System Service Data Sheet (Revision 2)
SD-13-4986	Bendix® ESP® EC-80™ Controller Service Data Sheet
SD-13-4986	Bendix® ESP® EC-80™ Electronic Controller Service Data Sheet
SD-64-20124	Bendix™ FLC-20™ Camera Service Data Sheet
SD-29-50024	Bendix™ FLC-25™ Camera Service Data Sheet
SD-61-4963	Bendix™ FLR-21™ Radar Sensor Service Data Sheet
SD-29-50022	Bendix™ FLR-25™ Radar Sensor Service Data Sheet
BW2681	Bendix® Fusion™ Active Safety System Operator's Manual (F1.0 - F2.3)
BW8122	Bendix® Fusion™ Active Safety System with ACB Auto-Resume Operator's Manual (F2.2) – PACCAR®
BW8203	Bendix® Fusion™ Active Safety System with ACB Stop and Driver-Go™ Operator's Manual (F2.10) – PACCAR®
BW8178	Bendix® Fusion™ Active Safety System with ACB Stop and Driver-Go™ Operator's Manual (F2.10) – International®
BW8154	Bendix® Fusion™ Active Safety System with Pedestrian Autonomous Emergency Braking (PAEB) Operator's Manual (F3.0) – PACCAR®
BW8190	Bendix® Fusion™ Active Safety System with Pedestrian Autonomous Emergency Braking (PAEB) Operator's Manual (F3.0) – International®
BW8247	Bendix® Fusion™ Active Safety System with Pedestrian Autonomous Emergency Braking (PAEB) Operator's Manual (F3.1) – PACCAR®
BW8246	Bendix® Fusion™ Active Safety System with Pedestrian Autonomous Emergency Braking (PAEB) Operator's Manual (F3.1) – International®
BW2769	Bendix™ VORAD® Collision Warning System Operator's Manual

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